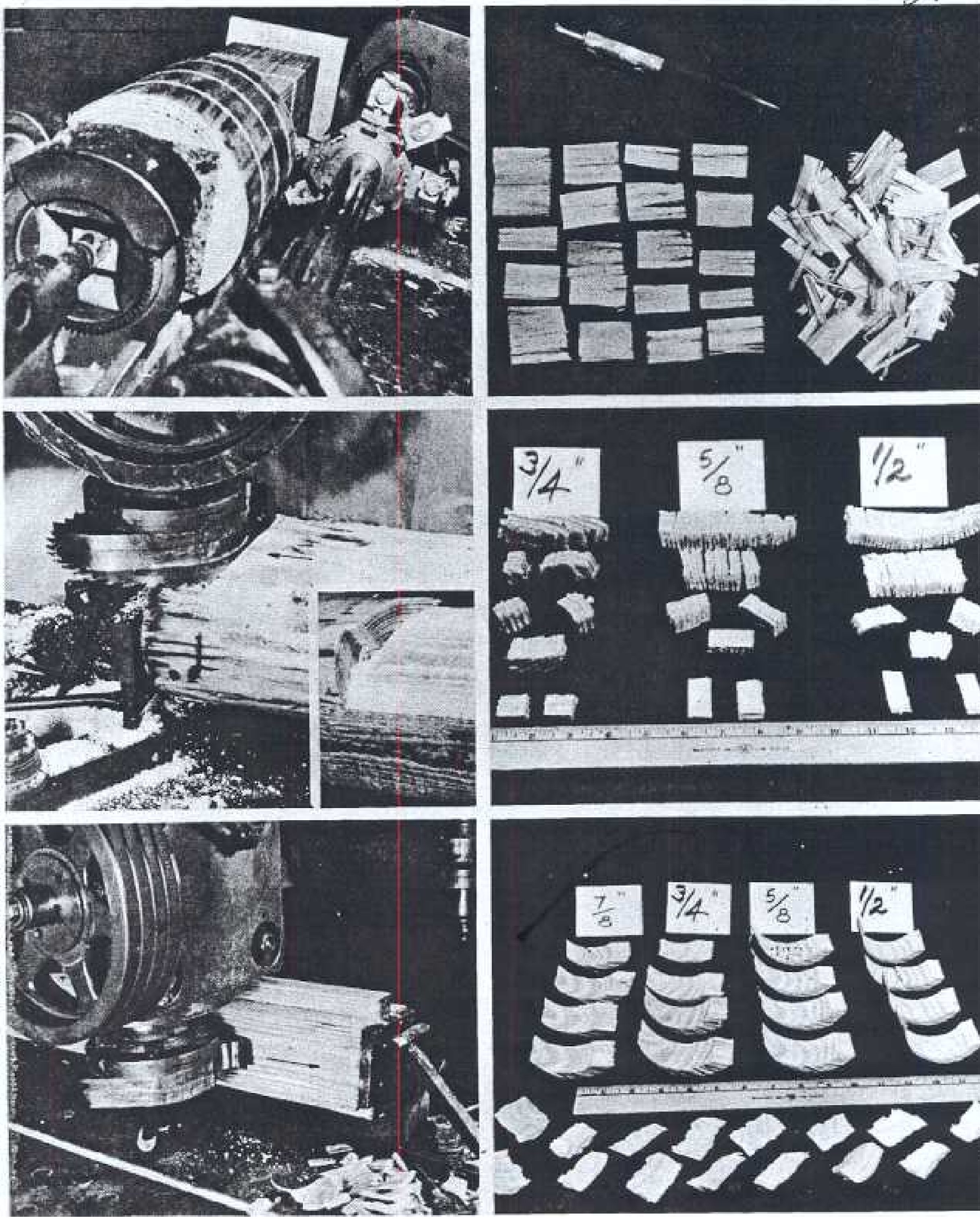
FOREST PRODUCTS RESEARCH SOCIETY
FOREST PRODUCTS JOURNAL



Three configurations of chipping headrig and resulting chips

(See page under Koch, 964

WOOD MACHINING REV EW

963 through 965

and

Part 1

Wood Machining Review, 1963 Through 1965

By

Peter Koch and C. W. McMillin

Southern Forest Experiment Station

Alexandria, La.

THE PURPOSE OF THIS PAPER is to review significant research that has not previously been digested in recent English-language texts[1] and bibliographies[2,3,4]. In general, only findings published during 1963, 1964, and 1965 are considered. The reviewers' principal sources were the major world journals in wood science and technology, *Forestry Abstracts*, and personal communication with researchers known to be active. Only papers of research nature were reviewed. The reviewers recognize and regret that limits of time and linguistic ability have probably resulted in omissions and misinterpretations.

After some debate, it was decided to proceed by abstracting individual papers and arranging the abstracts under subject-matter categories. This procedure gives the reader more information about individual studies than would be possible in a narrative account and hence should aid him in identifying contributions of special interest. The subject-matter heads are listed in the box on this page.

While any general appraisal must reflect individual biases, their survey left the authors with some strong impressions.

For one thing, the total research effort seems to be accelerating, with increased numbers of workers active. The 198 references attest the fact.

For another, a substantial amount of recent research is being put into application. Thus the work of Plough (1962), McKenzie and Franz (1964), and St. Laurent (1965) on the principle of inclined cutting has seen application in 1966 through the development and installation of an oscillating-knife veneer lathe by a major forest products manufacturer in the United States.

Abrasive belt machining, while meagerly reported in English-language archival journals, has made striking progress in recent years, with applications primarily in the particleboard and plywood industries. Some trials on solid wood have been reported by Ward (1965).

Box Outline

This year will see accelerating use of chipping headrigs in the United States. The benefits inherent in two industrial designs of peripheral-milling headrigs are discussed by Pease (undated-1964?) and Dobie and McBride (1964), while a modified end-milling configuration is described by Wretne (1965). Koch (1964) continued his 1955 and 1956 work on chip formation during rotary cutting by exploring three configurations of chipping headrigs (cover photo). Of these three, only the shaping lathe configuration has not yet been applied to industrial headrig designs.

Further, research is extending into areas that have been largely overlooked. The paper by Ward-

[1] Koch, Peter. 1964. Wood machining processes. Ronald Press Co., New York. 530 pp.

[2] Committee on Recent Wood Machining Literature. 1961. Wood machining abstracts, 1959-1961. For. Prod. Res. Soc., Madison, Wis. 18 pp.

[3] Committee on Recent Wood Machining Literature. 1960. Wood machining abstracts, 1958-1959. For. Prod. Res. Soc., Madison, Wis. 19 pp.

[4] Committee on Recent Wood Machining Literature. 1959. Wood machining abstracts, 1957-1958. For. Prod. Res. Soc., Madison, Wis. 20 pp.

rop and Addo-Ashong (1965) on anatomy in relation to mechanical failure was particularly illuminating. Knowledge of the disk defibration process has been furthered in work by Atack and May (1962, 1963), Dorland (1962), and Holzer (1962). Phenomena related to the dulling of cutting edges have been studied by Englesson (1964), Hillis and McKenzie (1964), Nosovskii (1963), and Pahlitzsch and Dziobek (1961). Stability of saws has received detailed analysis by Jones (1965), Mote (1964, 1965), and Thunell (1962, 1963, 1964).

Background

History and General Texts

Goodman, W. L. 1964. The history of woodworking tools. G. Bell and Sons, Ltd., London. 208 pp.

Invention was active in three periods: Roman times, between 1400 and 1500 A.D., and finally, in the 18th century, which the author considers the golden age of hand woodwork. Contains a 42-entry bibliography, a list of British museums with tool displays, and a 3-page index.

Serry, Victor. 1963. British sawmilling practice. Ernest Benn, Ltd., London. 232 pp.

An elementary text with introductory comments on the structure of the lumber industry in Britain. Considers (but does not discuss in depth) types of sawmills, workshop practice, tools and maintenance (including planers), sawmill organization, wood anatomy, and the future of sawmilling in Britain. A 4-page appendix outlines statutory requirements applicable to British woodworking factories.

Vorreiter, Leopold. 1963. Holztechnologisches Handbuch, Band III: Grundlagen der Holzzerspanung Arten, Formen and Maschinen zerspanender Holzformung Arbeits- und Betriebsschutz. Verlag Georg Fromme & Co., Vienna and Munich. 868 pp.

This third volume in Vorreiter's series of wood technology handbooks is concerned with all aspects of wood machining. The first section discusses fundamentals of mechanical wood conversion, the second and major section describes individual machines and methods according to function, and the short final section is concerned with safety. The text contains 84 tables and 633 good illustrations. The 7-page list of references omits mention of such well-known English-speaking researchers as Franz, Goodspeed, Leney, Lubkin, and McKenzie. Generally speaking, the machines illustrated are of European manufacture. The principles elucidated are, or course, universal. Text in German.

Properties of Wood

Wardrop, A. B., and F. W. Addo-Ashong. 1965. The anatomy and fine structure of wood in relation to its mechanical failure. CSIRO Div. For. Prod. (S. Melbourne) Rept. 560. 32 pp. (See also Addo-Ashong, F. W. 1964. Univ. Melb. M. Sci. Thesis. 117 pp.)

Summarizes the structure of hardwoods and softwoods (initial 14 pages). In the light of this structure examines the changes in anatomy and fine structure of wood resulting from mechanical failure. Concludes that, in compression parallel to the grain, the initial zone of failure lies between the secondary wall layers S_1 and S_2 within the fibers, thus causing increasing stress on adjacent fibers and deformation within them as well. With further increase in load, the number of cell wall deformations is increased, and stress concentration buckles the fiber walls, with consequent failure between fibers or between ray parenchyma cells; buckling lines are recognizable under the microscope. When wood is compressed perpendicular to the grain, the low modulus of elasticity results from a change in the cross-sectional form of the cells and does not involve the properties of the cell wall constituents in a direct way; that is, with slight forces the cell walls bend inward or are distorted sideways. As with compression parallel to the fiber length, layer S_1 separates from S_2 when failure occurs. Individual fibers exhibit greater wet strength in tension than do dry fibers, whereas with whole wood, the opposite it true. The increase in strength of whole wood on drying can be attributed to the formation of additional bonds between the lignin, matrix (hexosans, pentosans, substituted pentosans, and polyuromic acids), and the cellulose framework. Short fibers with large microfibril angles break under a smaller load than do long fibers with small angles. Therefore, long fibers require a larger area of overlap with adjacent cells to develop their intrinsic strength. Tension failures, in common with compression failures, usually occur within the fiber between the S_1 and S_2 layers. In wood subjected to radial shear forces, lines of failure generally follow the rays but also involve some rupture of the fiber walls. In some specimens, tangential shear causes fracture at the junction of earlywood and latewood and is further affected by rays and vertical parenchyma, but fracture of fiber walls also occurs. These fractures lie between the layers S_1 and S_2.

Analysis of Cutting Process

Orthogonal Cutting

Ickovic, E. A. 1963. The direction of the stresses in wood when a cutter penetrates it. Lesn. Z. Arhangel'sk 6(3): 144-118.[a]

Brittle-lacquer techniques were used to study stress distributions in the workpiece ahead of the cutter along the three principal wood axes. Stresses were not significantly related to cutter geometry but were determined by the microgeometry of the cutting edge.

Solovev, A. A. 1962. The kinematics of vibration cutting. Lesn. Z. Arhangel'sk 5(6): 114-124.[5]

A detailed mathematical analysis of vibrational cutting for the special case of uniform feed, linear vibrations in the feed direction, and a cutter assumed to be a flat knife without teeth.

Inclined Cutting

McKenzie, W. M., and N. C. Franz. 1964. Basic aspects of inclined or oblique cutting. For. Prod. Jour. 14(12): 555-565.

Inclined cutting perpendicular to the fiber direction, accomplished by a rotating disk, has considerable benefits related to the velocities parallel and perpendicular to the cutting edge. Cutting force decreases as the tangent of inclination increases, stabilizing at a minimum of half that observed at zero inclination. Reduced cutting forces and improved surface quality are initially attained with less input energy (higher cutting efficiency), but input increases at the higher inclination angles necessary for maximum surface quality. The benefits of inclination are primarily due to minimizing the spread of stresses and deflections as the cutting edge advances into the cell structure. At low rake and high inclination angles, forces are transferred to a direction where the shear strength of wood is less. Edge bluntness, abrasion, and heat also importantly affect the incision of fibers.

McKenzie, W. M. 1965. The effects of edge bluntness in the cutting of wood. IUFRO, Sec. 41, October Meeting, Melbourne.

Hypothesizes that, when chip formation causes a tensile stress across the cutting plane, the ratio of severance force to chip-deflection force will depend on the ratio of the square root of the edge radius to the chip thickness, and will be independent of rake angle, wood properties, moisture content, and grain direction. Since the severance force and energy are greatest for cutting in the transverse planes, any cutting device must concentrate extreme energy to be efficient and produce quality transverse surfaces.

McKenzie, W. M., and B. T. Hawkins. 1965. Trimming plywood by inclined cutting using a disk. For. Prod. Jour. 15(9): 405-406.

When plywood of refractory species is saw-trimmed, the edges splinter to some degree. With inclined cutting it may be practical to retrim such panels to eliminate breakout. Tests were made with a toothless disk 11-1/2 inches in diameter and with rake angle of 50°, clearance angle of 5°, and cutting-edge radius of 6 microns. At a rim spread of 600 feet per minute and feed speed of 1-1/2 feet per minute ($v_s/v_x = 400$), the disk satisfactorily trimmed 3/8-inch, 3-ply plywood made from mountain ash (*Eucalyptus regnans*) if the plane of the plywood were 2-1/2 to 4-1/2 inches from the center of the disk. Thus the angle between the tangent to the disk periphery and plane of the sheet was 23° to 38°, and the resultant cutting force component lay within the plywood, that is, with no outward component.

Plough, I. L. 1962. The use of a vibrated knife to machine superior wood surfaces. Univ. Mich. Dept. Wood Sci. and Tech. M. Sci. Thesis.

A vibrating knife produced a superior end-grain surface, presumably by kinematic reduction in rake angle. Proposes a rotating conical knife to achieve continuous inclined cutting.

St. Laurent, A. 1965. Effect of induced lateral vibration of a saw tooth on the cutting of wood. For. Prod. Jour. 15(3): 113-116.

Parallel cutting force exerted on a single swaged tooth (1/4-inch wide inserted-type for circular saw), having 35° rake angle and 10° clearance angle, was measured when cutting a 0.01-inch-thick chip from the end grain of a 0.15-inch-wide piece of hard maple at 4-percent moisture content. The tooth was subjected to lateral vibration. At cutting speeds below 3-1/2 feet per minute, double vibrational amplitude of 0.10 to 0.015 inch, and vibrational frequencies of 50 to 200 cycles per second, parallel cutting force was substantially less than when the tooth was not vibrated. Force was decreased 50 to 70 percent if cutting speed was reduced to 2-1/2 feet per minute. Surface quality was increased in inverse proportion to parallel cutting force. No reduction in parallel cutting force was observed when: 1) cutting speed was increased above 3-1/2 feet per minute, or 2) chip thickness was increased above 0.016 inch, or 3) vibrational frequency was more than 300 cycles per second, or 4) vibrational double amplitude was less than 0.04 inch, or 5) the wood was wider than the tooth.

Peripheral Milling

Bier, H., and P. Hanicke. 1963. The specific cutting force as a function of the blunting of knife edges in rotary cutting. Holztechnologie (Dresden) 4(2): 158-162.[5]

[5]The citations and abstracts marked with a superscript 5 are taken by permission (with some revision) from Forestry Abstracts, Commonwealth Forestry Bureau, Oxford, England.

In planing particleboard and end-grain beech, cutting force increased 300 percent between sharpening and removal for resharpening. As blunting proceeded, power requirement increased more rapidly at slow than at high feed speeds.

Goodchild, R. 1963. Investigating finish in rotary planing. Engineering 159(5049): 172-173.

A transducer is described that permitted profile determination of a rotary-planed surface. Measured depth of knife traces agreed with calculated values. Profiles differed somewhat by species. Heavy hold-down pressures reduced depth of knife traces.

Komarov, G. A. 1964. Interaction of the cutter with the wood in transverse milling. Lesn. Z. Arhangel'sk 7(4): 107-112.[5]

The relationship of the radial and tangential cutting forces to chip thickness is graphed for five cutting-schedule factors. Power consumption was at minimum with the following schedule: clearance plus sharpness angle 40° to 45°; clearance 5° to 7°; cutting speed 30 to 40 meters per second; nominal chip thickness 0.3 to 0.5 millimeter; moisture content 10 to 12 percent; edge radius 4 to 10 microns.

Mori, M., and T. Hoshi. 1963. Studies on surfacing wood with planer. (II)—Effect of cutting factors on the surface quality of finish. Bull. For. Exp. Sta. (Meguro, Tokyo) No. 160: 19-35.[5]

Effects on surface roughness were established for: 1) feed per knife; 2) the minimum feed per knife visible to the naked eye (0.5 to 1.6 millimeter) for a group of 6 timbers; 3) setting precision of the knives in the cutterhead; and 4) progressing knife wear. Feed per knife, depth of cut, cutting angle (rake angle?), and distance between knife edge and chipbreaker (gib?) were studied. The most critical factors were feed per knife and cutting angle. Chipbreaker (gib?) settings are recommended for hardwoods and softwoods. Difficulties in planing each species are listed with frequency of each type of defect attributable to each factor.

Mori, M., and T. Hoshi. 1964. Studies on the surfacing of wood with planer. (III)—On the precision of jointing the knives, and (IV)—Effect of "land" at knife edge upon cutting efficiency. Bull. For. Exp. Sta. (Meguro, Tokyo) No. 163: 47-64, 65-76.[5]

Part III describes effectiveness, in a 4-knife cutterhead, of initially setting individual knives to less than 0.1 millimeter protrusion, grinding to 10 to 75 microns, preliminary jointing and final jointing to 10 to 50 and 5 to 10 microns, respectively. Cutting angles, feed speeds, and their effect on various species are discussed. Part IV concludes that a wide "land" caused by a heavy joint gave an inferior surface and short knife life; range of widths tested was 0.01 to 0.9 millimeter.

Noguchi, M., H. Sugihara, and S. Nishikawa. 1962. Studies on wood cutting with a pendulum dynamometer. (II)—Effect of clearance angle. Jour. Jap. Wood Res. Soc. (Meguro, Tokyo) 8(6): 260-265.

Energy consumption in cutting beech increased with clearance angle, being minimal at clearance of 5° to 15°. The greatest effects were observed with thick chips. Clearance had little effect in radial or tangential cutting perpendicular to the fibers but strongly affected energy required in cutting parallel to the fiber axis. In all cutting directions, energy consumption increased with chip thickness. It did not differ between radial and tangential cutting in a plane perpendicular to the fibers.

Noguchi, M., and H. Sugihara. 1963. Wood cutting with a pendulum dynamometer. (III)-Effect of specimen shape and cutting direction. Wood Res. (Kyoto) No. 30: 1-14.

A test to determine the effects of sample shape, cutting direction, and knife material (carbon tool steel, chromium plated, and tungsten-carbide tipped) on energy consumption proved inconclusive. Energy consumption increased with cutting depth in all directions, but less in the radial than transverse direcion. Consumptions for *Fagus crenata, Chamaecyparis obtusa,* and *Shorea spp.* are compared.

Noguchi, M., H. Sugihara, and Y. Kamijo. 1964. Wood cutting with a pendulum dynamometer. (IV)—Effect of rake angle. Jour. Jap. Wood Res. Soc. (Meguro, Tokyo) 10(1): 10-16.[5]

Rake angle was the major factor affecting energy consumption in cutting *Fagus crenata, Chamaecyparis obtusa, Shorea philippinensis,* and *S. negrosensis.* Energy consumption decreased with increasing rake angle, the rate of decrease depending more on cutting direction than species, moisture content, sharpness angle, or cutting depth. Energy consumption was proportional to specimen length in the cutting direction.

Noguchi, M., H. Sugihara, and R. Matsuyoshi. 1965. Wood cutting with a pendulum dynamometer. (V)—Effects of moisture content. Wood Res. (Kyoto) No. 34: 45-53 (English).

1) Specific cutting energy increases with moisture content up to approximately 20-percent moisture content (variable by species) and then decreases; 2) specific cutting energy is proportional to specimen length; 3) energy consumption is largest in transverse cutting. Tangential cutting in the peeling direction uses least energy. In the radial direction, the energy is the same whether cutting bark-to-pith or vice versa.

Pahlitzsch, E. H., K. Dziobek, and I. Sommer. 1965. Formation and separation of chips in the planing of wood. Maschinenmarkt (Würzburg) 71(45):27-34.

By means of very high-speed photographs (10,000 frames per second) chip formation in up- and down-milling was analyzed when cutting pine, beech, and poplar.

Sugihara, H., and M. Noguchi. 1962. Studies on wood cutting with a pendulum dynamometer. (I)—Effect of tool angle and clearance angle. Wood Res. (Kyoto) No. 28: 31-49.

Energy consumption was minimized with a sharpness angle of 35° and increased with larger sharpness angles. High clearance in combination with high rake increased energy requirements. Cutting energy was inversely proportional to rake angle. It was minimized if the cutting edge was parallel to the grain and motion was perpendicular to the grain.

Sugihara, H., and M. Noguchi. 1963. Depth of cut, thickness and weight of removed chip and consumed energy in wood cutting. Wood Res. (Kyoto) No. 30: 34-39.[5]

Laboratory tests on *Fagus crenata, Chamaecyparis obtusa,* and Lauan (*Shorea spp.*).

Weber, A. 1962. Magnetostrictive measurements of the cutting force in wood moulding. Holz als Roh- und Werkstoff 20(12): 486-492.[5]

Describes the principles of magnetostrictive measurement of cutting force and the test rig used to make such measurements in spindle-moulding beech, Finnish birch, and spruce under different conditions of grain angle, feed speed, depth of cut, and cutting speed. Cutting forces sometimes exceeded those reported in the literature. Mean chip thickness did not prove to be a suitable reference, particularly for thick chips. It was possible to calculate a specific cutting force from direction of cut and feed speed. Moulding machine power requirement could be calculated from cutting force and time.

Processes Directed Toward the Workpiece

Barking

Berlyn, R. W. 1965. The effect of some variables on the performance of a drum barker. Woodl. Res. Index, Pulp and Pap. Res. Inst. Can., No. 173. 14 pp.[5]

Berlyn, R. W. 1965. The effect of variations in the strength of the bond between bark and wood in mechanical barking. Woodl. Res. Index, Pulp and Pap. Res. Inst. Can., No. 174. 22 pp.[5]

Bond strength and bark thickness appeared to influence the performance of ring barkers.

Hanson, T. P. 1965. Major innovations in barking drum design. Pap. Trade Jour. 149(13): 36-37.

A drum has been designed in 15-foot sections with inside diameter of 12 feet and discharge openings of 11 feet. Staves are of steel pipe. Standard 33-inch freight-car wheels support and drive against 100-pound railway track (bent to conform to drum circumference); a hydraulic motor achieves a drum speed of 8 rpm. For design purposes, a coefficient of friction between wheel and rail was conservatively assumed to be 0.12 under wood-room conditions (compared to railway experience of 0.22 for wet rail and 0.30 for dry rail). A 60-foot drum will clean 25 to 55 cords per hour. On frozen wood, tank sections are desirable, and when they are used, barking capacity is proportional to water temperature. The tank section requires some 2,000 gpm of water at a minimum of 60°F.

Grammel, R., and J. Ott. 1965. Mechanical barking of small conifer stemwood. Holz Zentralblatt 91(97): 1683-1685.[5]

Los, A. P. 1965. Operating regimes of (rossing-type) barking machines. Lesn. Prom. (4): 25-27.[5]

The equipment should be adjustable so that from 1 to 6 blades can be made to pass over each part of the log surface.

Nakamura, G., and Y. Obira. 1963. Industrial trials of bark removed by means of drum debarker. Bull. For. Exp. Sta. (Meguro, Tokyo) No. 155: 87-109.[5]

Investigates efficiency of a small drum barker with a central driveshaft, and one with a basket-type rotor. Evaluates the parameter c in the equation: $w = W\,(1 - e^{-ct})$, where w is weight (kilograms) of bark to be removed, W is weight of material (including bark) loaded into the drum, and t is the operating time (minutes). Types of material, number of drum revolutions, and apparent loading capacity are main factors affecting c.

Nakamura, G., and Y. Obira. 1964. Fundamental studies on debarking by means of a small-size drum rotor. (I)—On the observation of movement of materials and the progress of debarking by the horizontal rotating drum. Bull. For. Exp. Sta. (Meguro, Tokyo) No. 164: 159-181.[5]

Sticks 8 to 14 millimeters in diameter coated with an artificial "bark" of sawdust glued in place with a fast-drying paint were processed in a bench-model barking drum 300 millimeters in diameter and 400 millimeters long, with glass ends and driven by a 1 horsepower motor. An index of bark removal was investigated. Effects of barking bar, speed of drum, and loading capacity are summarized. Velocity and types of material movement within the drum are discussed. Movement is similar in drums of different diameter (D) if the ratio of revolutions per minute to $\sqrt{D}$ is held constant.

Nakamura, G., and Y. Ohira. 1964. Industrial trials of bark removal. (III)—On the drum barker equipped with a central driving shaft having a spiral cutting edge. Bull. For. Exp. Sta. (Meguro, Tokyo) No. 171: 155-168.[5]

At 60-percent loading a drum barker with central drive shaft with spiral cutter removed 90 percent of the bark in 2 hours compared to 8 hours for an ordinary drum barker. The shape and sharpness of the cutting edge (at present damaging the wood), the speed of the shaft, and the method of bark removal, all require study to improve the rate of bark removal.

Orlov, A. T. 1964. Barking birch for rotary veneer cutting. Derev. Prom. 13(4): 11-12.[5]

After first being submitted to an "impact" treatment by means of a pneumatic hammer device to weaken bark cohesion, birch bolts were debarked conventionally. Marked bark deformation was observed at 0.8 to 1.2 kilogram per square centimeter (specific impact force). The responses of frozen, hot-water-soaked, freshly felled, and old material are briefly discussed.

Pokryskin, O. V. 1965. Schedules for barking frozen wood. Lesn. Prom. (3): 12-14.[5]

Experiments with a barker equipped with a rosser head (i.e., a rotating cutterhead) showed that r, the radius of rounding of the knife edge, depends on the condition of the wood and the sharpness angle of the knife. With sharpness angles of 45° and 65°, r should be respectively 1.0 to 0.8 and 0.3 to 0.5 millimeter for frozen wood. With sharpness angles of 45° and 60°, r should be respectively, 2.0 to 2.5 and 1.5 to 1.0 millimeter for floated and freshly felled wood. A feed speed of 15.9 meters per minute is recommended for frozen wood with $Kr = 3$ (Kr being the number of cutter knives that pass over each part of the wood surface), and 23.8 meters per minute for floated and freshly felled wood with $Kr = 2$. Static pressure of the cutter should be 35 to 40 kilograms per centimeter of lineal cutting edge for frozen wood and 18 to 26 kilograms per centimeter for other wood. Rotor speeds should be 170 to 190 rpm.

Salminen, J. 1964. Barking of birch and small-sized pulpwood in silo barkers and barking drums. Tied. Metsäteho (Helsinki) No. 223. 24 pp.[5]

Surveys operation of several barking plants using various barkers. Soaking and heating are recommended for dry or frozen logs prior to barking.

Sawing

Anon. 1964. Loss from variation in sawing precision. U.S. Forest Serv. Res. Note FPL-069. 3 pp. U.S. Forest Prod. Lab., Madison, Wis.

Explains procedure for determining the optimum setting thickness for boards. The procedure assumes that the sawmill has been adjusted for its most accurate work. Revised from C. J. Telford's FPL Rept. 899-2, dated 1953.

Antoine, R. 1964. "Static" sawing and pulpable kerf material. Timber Trades Jour. 250(4589): 53, 55.[5]

Describes a saw consisting of a series of fixed teeth or gouges, arranged one above the other, each taking a deeper bite than the preceding one as the work passes between them. Thus, continuous shavings suitable for pulping are produced.

Aoyama, T. 1964. An experiment on variation of bandsaw speed. Bull. For. Exp. Sta. (Meguro, Tokyo) No. 163: 35-46.[5]

A stepless speed changer was used to study the interactions of cutting and feed speed, feed per tooth, sawing area per tooth, gullet area, and power consumption. Under severe conditions, use of a speed changer might prevent overload.

Bailey, J. R. 1963. Noise and vibration in chain saws. Soc. Automotive Eng. Nat. West Coast Meeting, Seattle, Aug. 19-22. 10 pp.

Bersadskij, A. 1964. Calculation of ripsawing schedules. Lesn. Prom. (12): 8-13.[5]

A mathematical treatment of ripsawing, including formulae for calculating specific work.

Birkeland, R., and G. Hvamb. 1963. Studies of sawing accuracy of bandsaws when sawing frozen and unfrozen logs. Norwegian Inst. of Wood Working and Wood Tech. Rept. 23. 10 pp. (Also Norsk Skogindustri 17(8): 283-389; also U.S. Forest Prod. Lab. Translation 554.)

With a band resaw cutting spruce (*Picea excelsa*): 1) optimum bite per tooth was approximately 1 millimeter in both frozen and unfrozen logs; 2) a tooth pitch of 1.5 inch gave better accuracy than a 2-inch pitch in both frozen and unfrozen logs; 3) best accuracy was obtained at a saw speed of 30 meters per second on both frozen and unfrozen logs; 4) because of greater water and ice content in sapwood, sawing accuracy was less on boards sawn from frozen sapwood than on boards sawn from frozen heartwood; 5) sawdust had a greater tendency to freeze to the sawn surface of sapwood than to heartwood; and 6) the power demand is greater for frozen than for unfrozen logs.

Cowling, R. L. 1964. Geometrical determination of lateral back bevel angle (top bevel angle) for circular saws. CSIRO Div. For. Prod. (S. Melbourne) Tech. Pap. 31. 20 pp.

A geometrical determination of top bevel angle for spring-set saws based on the threshold of side interference. Single and double back-bevel teeth are considered. A general case equation cannot be solved analytically although approximations enable a graphical solution for the more common ripsaws.

Cowling, R. L. 1965. The clearance angle of circular ripsaws. Australian Timber Jour. 31(3): 43-52.

The abrasion of white lacquer sprayed on the tooth tops of circular saws whose clearance angle ranged from 0° to 21° decreased with increasing clearance under practical conditions, but was constant under laboratory sawing where tooth deflections were minimized. Tooth deflection strongly influences the clearance angle required in practice. The direct influence of bluntness, feed speed, species, and depth of sawing on clearance requirement appears small, but all these factors may contribute to tooth deflections. A 15° clearance is recommended for Australian mills.

Cuprin, V. I. 1964. Sawing hardboards with circular saws. Lesn. Z. Arhagel'sk 7(6): 116-124.[5]

Describes experiments to determine effect of a number of process variables on specific work and surface quality when sawing hardboards (0.0968 gram per cubic centimeter) in sets of four (total thickness 12 millimeters), with a circular saw having teeth with rake angle of 10°, clearance angle of 15° to 17°, and front bevel of 75°.

Dargan, E. E. 1964. Potential of furniture round manufacture. Unpublished pap., annual meeting, S. E. Sect., For. Prod. Res. Soc.

A three-tooth, 1/4-inch kerf, tubular saw driven at 3,600 rpm by a 75-horsepower motor produces 10 round dowels per minute from short logs. The log remains stationary while the saw passes through it and is withdrawn. The log is then turned and another round extracted. Capacity is approximately 3,500 to 4,000 four-foot rounds in 8 hours. Sawdust is ejected from the initial cut by an ejection slit cut in the log. Subsequent ejection is into the void left by the preceding round. Rounds are solid-piled and kiln-dried without sticks.

Endersby, H. J. 1964. Framesawing and conversion efficiency. Timber Trades Jour. 251(4605): 59-64.

Analysis of typical two-gangsaw mill in Germany with emphasis on necessity of high recovery. Attempts comparable analysis on assumption of same mill operating in Britain.

Feoktistov, A. E. 1964. The capacity of bandsaws. Holztechnologie (Dresden) 5(4): 253-259.[5]

Capacity was limited by deterioration of sawing quality above a critical feed speed. For cutting dry or green conifers at a cutting depth of 10 to 30 centimeters and saw speeds of 45 and 25 meters per second, the specific work was least for feed speeds of approximately 0.9 and 1.05 to 1.15 millimeters per tooth, respectively. Sawing at minimum specific cutting energy rarely produced accurately cut boards.

Fischer, R. 1964. Working characteristics of intermittent feeds on frame saws. Holztechnologie (Dresden) 5(2): 93-96.[5]

A theoretical discussion of inertia forces, feeding power, and main cutting force during one cycle of the frame (sash). Recommendations given for feed speed and lead to avoid cutting upward. Overhang yet to be tested.

Fukui, H., and T. Sato. 1964. Investigations on cutting action of tip edge of circular saw tooth in ripsawing, principally on the effect of hook angle. Jour. Jap. Wood Res. Soc. (Meguro, Tokyo) 10 (2): 62-67.[5]

Gulowsen, K. T. 1964. What is gained by sawing with thin cuts and with greater accuracy? Norsk Skogindustri 18(6): 210-211. (Also CSIRO Australian Translation 7145.)

1) If a square is cut from a log, a thin kerf will not increase yield. 2) If the square is reduced to two planks, the yield per plank will increase by half the saving in kerf. 3) If there are n planks, the yield per plank will increase by $(n\text{-}1)/n$ times the saving per kerf.

Hallock, H. Y. 1964. Kerf width and lumber yield. For. Prod. Jour. 14(2): 80-84.

In logs 5.5 to 12 inches in diameter, sawing with a 9/32- instead of a 12/32-inch kerf increased lumber recovery 2.9 to 33.3 percent (average 7.3 percent). In some diameter classes no increase occurred. While the increase was maximum for logs 12 inches in diameter and less, results were erratic for logs of very small diameter.

Hallock, H. Y., and E. Jaeger. 1964. Some aspects of sawing accuracy in circular mills. U.S. Forest Serv. Res. Note FPL-029. 9 pp. U.S. Forest Prod. Lab., Madison, Wis.

When small loblolly pine logs were sawn into 8-foot 2 by 4's in a well-maintained circular sawmill: 1) it was possible to produce 95 percent or more studs with an overall thickness variation of ±2/32-inch and an overall width variation of ±3/32-inch; 2) variation between boards was a little less than variation within boards; 3) there appeared to be no statistically significant difference between sizing accuracy of studs from logs with and without compression wood; and 4) when studs are individually classified into one of three classes —no compression wood, mixed compression wood and normal wood, and all compression wood—the sizing variation of the mixed class was significantly greater than either of the other two classes or the mean variation of all three classes.

Continued on p. 107

Wood Machining Review,
Continued from p. 82

~~*Hallock, H. Y.*~~ 1965. Sawing to reduce warp of lobolly pine studs. U.S. Forest Serv. Res. Note FPL-51. 53 pp. U.S. Forest Prod. Lab., Madison, Wis.

Relates sawing methods, log diameter, juvenile core diameter, log position in tree, presence of compression wood, log eccentricity, and position of the stud in the log to warp in 2 by 4 studs sawn from small loblolly pine logs. The incidence of severe crook and bow was much greater in butt than in upper logs. The sawing system prescribed as best is to: 1) saw a round-edge central 4-inch cant and two round-edge 8/4 sideboards; 2) edge the two sideboards in conventional fashion to yield one or two 2 by 4's; 3) edge the central cant parallel to the bark to yield 2 by 4's plus a discarded central wedge containing the pith.

Hasden, S. M., et al. 1964. Cutting forces on a deep-cutting frame saw. Derev. Prom. 13(12): 14-15.[s]

A strain-sensitive transducer system is described for measurement of cutting forces. The effect of blade lead, blade thickness, feed, kerf height, and feed mechanism on cutting forces was determined. Eighty-five percent of the total work was performed in the working stroke. Peak vertical force was 3.5 to 5 times its mean value, while the peak horizontal force was 9.5 to 11 times its mean value. The peak feed force averaged 2.5 times the mean cutting force.

Jones, D. S. 1959. Thinner circular saws. Australian Timber Jour. 25(6): 15-30.

Within certain limitations, thin circular spring-set saws use less cutting power than thicker saws. Other factors being equal, power demand is proportional to kerf width. Tests confirmed that at rim speeds lower than the conventional 10,000 feet per minute (8,500 and 7,800 feet per minute were tried) chips were thicker and specific cutting power—hence total horsepower—was thereby reduced. For each saw, power demand was minimized at some optimum rim speed related to the vibrational stability of the teeth or to gullet overload. A stronger tooth profile is described and recommended.

Jones, D. S. 1963. The performance of thin circular saws in several dense species. Australian Timber Jour. 29 (1): 17-25.

Rim speeds in the range from 6,000 to 10,000 feet per minute were tested on wood of dense species. Initial reductions below 10,000 feet per minute achieved some power saving, because chips were thicker. With spring-set saw teeth, however, a critical speed was reached at which the increased bite per tooth deflected the teeth, widening the kerf and therefore raising power demand. Swaged teeth were more stable than spring-set teeth, but required more power because bite per tooth was less. Saw diameter was 37.75 inches; gauges were 10, 11, and 12. The saws had 54 teeth.

Kivimaa, E. 1964. A new sawing method. ECE Symp. Econ. Aspects Sawmill Ind. (Geneva) TIM/SAW/6. 16 pp.[s]

Kolcanov, B. D. 1963. The effect of kerf position relative to the annual rings, and its distance from stem center, on the specific work of cutting when ripsawing. Lesn. Z. Arhangel'sk. 6(4): 111-115.[s]

Specific cutting energy and power requirements increase with increasing distance of the kerf from the pith.

Matvejko, A. P. 1965. Schedules of ripsawing wood with circular saws. Lesn. Prom. (8): 9-11.[s]

Pahlitzsch, G., and Peter Rose. 1964. Investigations on the circular sawing of wood. Holz als Roh- und Werkstoff 22(9): 332-345.

In studies on a highly instrumented research sawing machine, axial vibration of the saw blade was influenced by cutting force, roughness, and chip size. Bite per tooth, chip thickness, depth of cut, and blade protrusion also affected cutting forces.

Petrovskij, V. S. 1964. Construction of an automatic optimization system for cross-cutting stems, with the aim of using digital computers to control the breaking down of tree-length logs. Lesn. Z. Arhangel'sk 7(4): 147-157.[s]

A detailed mathematical exposition.

Priest, D. T. 1964. The testing of chain saws. Commonwealth For. Review 43(3): 246-250.

Test apparatus is described. The horsepower obtained at the cutting point is, on the average, about half the horsepower rating of the engine alone. The sprocket, chain, and guidebar therefore absorb approximately half the available power.

Quelch, P. S. 1964. Sawmill feeds and speeds. Band and circular rip saws. Armstrong Manufacturing Co., Portland, Oregon. 46 pp.

Practical data, in tabular form.

Reineke, L. H. 1964. Factors affecting saw capacity. For. Prod. Jour. 14 (6): 235-238.

Gullet volume and sawdust ejection mechanisms are discussed in relation to overloading and saw instability. Formulae to determine capacity limits for various saws are presented.

Row, Clark, Clyde Fasick, and Sam Guttenberg. 1965. Improving sawmill profits through operations research. U.S. Forest Serv. Res. Pap. SO-20. 26 pp. South. Forest Exp. Sta., New Orleans, La.

Batches of logs varying in diameter, grade, density, and position in tree were processed in a modern high-speed mill by several sawing patterns. Time required on each major machine to convert

1,000 board feet of logs to green lumber was determined. Optimum sawing pattern for each class of logs was decided by linear programming. The analysis evaluated the effects of increasing the log supply, sale of logs for pulpwood, changes in lumber sales policy, purchase of low-grade lumber, adding equipment, and changes in the relative prices of boards and dimension.

Sugihara, H., and K. Sumiya. 1964. Snapshot observation of band-saw dust movement in exhausting. Wood Res. (Kyoto) No. 32: 33-40.

A series of 36 photographs illustrating sawdust chambering and escape from the gullet.

Sugihara, H., M. Noguchi, et al. 1965. Study on the wood cutting ability of a single chain-saw tooth. Jour. Jap. For. Soc. 47(8): 275-281.[5]

Variation (according to moisture content, species, cutting angle, and direction) of energy consumed by a chipper-type saw tooth.

Thunell, B. 1963. Potential increases in the production capacity of frame saws in relation to factors of motion. Holztechnologie (Dresden) 4(3): 195-198.[5]

A theoretical discussion of frame-saw dynamics in relation to sawing efficiency. Production capacity might be increased by lengthening the stroke, but a reduction in rpm may be required because of higher mass forces. Sawing on the up-stroke may have advantages, but engineering problems related to saw stresses and log deformation are involved.

Tufanov, A. G. 1964. Sawing hard fiberboards with circular saws. Derev. Prom. 13(6): 13-14.[5]

Saws with a range of hook, clearance, and front bevel angles were tested on high-density fiberboards. Optimum angles were 40°, 13°, and 90°, respectively, at a cutting speed of 9,850 feet per minute and a feed of 5.9 feet per minute.

Turusev, V. G. 1963. Device for automatic feeding of cants into a frame saw. Derev. Prom. 12(5): 12-15.[5]

Discusses theoretical and practical aspects of sawing cants with sweep and describes a device for automatically feeding cants from the first to the second frame saw and processing them with maximum utilization.

Windelbandt, H. 1964. Continuous feed frame saws without disadvantages. Holz-Kurier (Vienna) 19(21): 14,16.[5]

Describes a swing-frame saw system that operates without cutting on the up-stroke.

Jointing, Planing, Molding, and Shaping

Cantin, Marcel. 1965. The machining properties of 16 eastern Canadian woods. Can. Dept. For. Pub. 1111. 27 pp.

A tabular presentation of machining characteristics based on visual examination of defects in samples. The effect of specific gravity and growth rate is included.

Davis, E. M. 1964. Woodworking machines. U.S. Forest Serv. Res. Note FPL-048 (rev.). U.S. Forest Prod. Lab., Madison, Wis.

Endersby, H. J. 1964. The planing of home-grown softwoods. Scottish For., April 18: 93-98.

Describes wood and knife characteristics affecting the quality of finish.

Grube, A. E., and V. I. Sanev. 1963. Dynamic investigation of the movement of pieces of wood in a thicknesser. Lesn. Z. Arhangel'sk 6(4): 145-158.[5]

A detailed analysis.

Prokes, S. 1964. Effect of the geometry of milling tools on their durability. Derv. Vyskum (3): 157-168.

Results, in graphical form, show that the best cutting angles are: clearance 15°, sharpness 55°, and rake 20° for tool steel and beech wood. Angles of 10°, 70°, and 10°, respectively, are recommended for carbide tools planing beech and particle and fiberboards.

Schmutzler, Wolfgang. 1964. The irregularity of feed movements in woodworking machines with feed drives by chains. Holz als Roh- und Werkstoff 22(14): 146-149.

The irregularities in feed movements of machines with chain drives are calculated. For a given feedworks configuration, feed irregularities depend on the number of links in the chain and are minimized by increasing the number of links. Since the irregularities influence only the workpiece feed velocity, they have no practical significance in sawing, but are of great importance in sanding and planing.

Schniewind, Arno P. 1963. Comparison of young-growth and old-growth redwood machinability, fastening strength, and shrinkage. Univ. Calif. For. Prod. Lab. No. 33. 8 pp.

Machinability tests were made at 6-percent moisture content on both flat- and edge-grain specimens. When bored holes were graded from 1 (best) to 5 (poorest machining quality), old-growth yielded 94 percent grades 1 and 2, as compared to 27 percent for young-growth. When shaped ends and edges were similarly graded, old-growth yielded 77 percent and young-growth 58 percent in grades 1 and 2. In planing tests, all were grade 3 or better; however, 69 percent of old-growth boards were in grade 1, as compared to 32 percent of the young-growth boards. While more difficult to machine than old-growth, young-growth redwood can be worked if machines are well adjusted. This review considers only the machining aspects of the report.

Turning

Narayanamurti, D., B. N. Prasad, and K. Singh. 1963. Temperature changes in woodworking tools. Norsk Skogindustri 17(9): 357-358.[5]

The temperature in the tool (?) was measured with a thermocouple during turning. Temperature increased with decreasing moisture content, reaching a maximum of about 140°C. In teak, it also increased with increasing rubber (?) content.

Boring, Routing, and Carving

Amalickij, V. V. 1962. Drilling chipboard. Derev. Prom. 11(11): 10-13.[5]

Presents a formula for calculating the energy required when drilling chipboards of different densities and binder content with bits of various diameters and cutting speed.

Hawkinson, Adolph H. 1965. Selection and maintenance of boring tools. Part I. Furniture Prod. Mag. 27(156): 20-24.

Discusses general problems in boring including species effects and hole tolerances. Makes specific recommendations for counter-boring and counter-sinking, mortising hardwoods, and for minimizing tool breakage.

Hawkinson, Adolph H. 1965. Selection and maintenance of boring tools. Part II. Furniture Prod. Mag. 27(157): 42-48.

Tool steels and designs with respect to boring requirements. Various tool types are illustrated.

Hawkinson, Adolph H. 1965. Selection and maintenance of boring tools. Part III. Furniture Prod. Mag. 27(158): 34-42.

Special processing of standard tools, various tools and their use, ordering and sharpening tools, and types of boring machines.

Mortising and Tenoning

Ljuboslavskij, V. D. 1964. Kinematics of the work of the slotting bit on drilling-and-mortising machines. Lesn. Z. Arhangel'sk 7(3): 96-109.[5]

A detailed theoretical study.

Sanding and Abrasive Tumbling

Hayashi, Daikuro, and Obi Hara. 1964. Studies on surface sanding of lauan plywood. Wood Ind. (Tokyo) 19(9): 1-6.

Lauan plywood was sanded parallel to the grain with wide belts having silicon carbide grits of 120, 150, 180, and 240 mesh; feed rate was 14.5 meters per minute and belt speeds were 482, 915, 1,350, and 1,783 meters per minute. The trials showed that: 1) degree of fuzzy grain was directly proportional to the rate of stock removal; 2) stock removal rate increased with belt speed and 3) with sanding pressure, but the curve had a maximum value related to grit size.

Jacjuk, A. I. 1965. Trial and prospects of sanding wood with abrasive disks. Derev. Prom. 14(7): 8-10.[5]

Pahlitzsch, G., and K. Dziobek. 1961. Determining the surface quality of machined wood surfaces. Part I—Methods of measuring and evaluating belt-sanded wood surfaces. Holz als Roh- und Werkstoff 19(10): 403-417. (Also translated by Joint Publications Research Service, U.S. Dept. Commerce, Washington, D. C. FPL-650. Dec. 1965.)

Surveys literature on surface measurements of sanded wood. Stylus-type surface probes are preferred to light and shadow microscopes. A moistened sanded surface yields profile information beyond that obtainable from the dry surface. Discusses technique for evaluating a sanded wood surface with deep anatomical or structural depressions.

Pahlitzsch, G., and K. Dziobek. 1965. The evaluation of machined wood surfaces. Part I. Holztechnologie (Dresden) 6(3): 153-160.

A profilometer was used to evaluate machined wood surfaces.

Rappleyea, Lee. 1965. The effect of different methods of sanding prior to finishing. Calif. Redwood Assoc., Res. Proj. Index No. 5.101015, Interim Rept. A, Nov. 1. 3 pp.

Schmutzler, Wolfgang. 1965. Spanning (tensioning) and controlling (guiding) of sanding belts. Holz als Roh- und Werkstoff 23(6): 240-244.

The tensile and axial forces on the belt largely determine the required belt strength and initial pre-stress force. A greater pre-stress force is needed for oscillating sanding belts. Contact-free pneumatic limit switches are used to prevent belt damage from axial movement.

Ward, Darrell. 1963. Abrasive planing challenges your knife cutting technique. Woodworking Digest 65(11): 29-32.

Tests with a wide-belt sander were run on oak and maple. Net horsepower per inch of belt width is plotted against depth of cut to show effect of feed direction and feed rate, and life is plotted against lineal feet run. Surface quality was improved and power requirement reduced if stock was fed against direction of abrasive rotation. High belt speeds yielded a better finish and lower specific cutting energy than low speeds. Total cutting power increased with feed rate. For sanding oak at 75 feet per minute at depths of cut of 1/32, 1/16, and 3/16-inch, cutting power per inch of belt width was respectively 2.2, 4.6, and 14 horsepower. At 20 feet per minute and 1/16-inch depth of cut, 0.9 horsepower was required. No appreciable dulling occurred in removing a 1/32-inch cut from 4,000 lineal feet of maple flooring at 80 feet per minute and 2.75 horsepower per inch of belt width.

Whelan, James E. 1965. High-tolerance, low-cost planing with abrasives. Ind. Woodworking 17(2): 20.

The ordinary conveyor-type feed is not satisfactory for abrasive planing. Power-driven, planer-type feed rolls are necessary. One installation of a two-head, top-and-bottom belt sander removed 0.06 inch per side from edge-bonded particleboard at 60 feet per minute. In this application an open-coat and flexible belt greatly increased belt life. In another belt sander installation, 0.022 inch was removed from rough oak flooring at 130 feet per minute.

Veneer Cutting

Anon. 1965. Veneer cutting and drying properties of water oak. U.S. Forest Serv. Res. Note FPL-0105. 6 pp. U.S. Forest Prod. Lab., Madison, Wis.

Logs of water oak (*Quercus nigra, Q. phellos, Q. laurifolia, and Q. lyrata*) are best cut into veneer if heated in long lengths to 140° to 150°F. (barking was more readily accomplished at 180°F., however), cut to bolt length, and then peeled with the lathe settings tabulated. Grub holes, knots, sweep, butt-swell, and flutes in logs should be avoided, as should protracted log storage without protective end coating. Green veneer will stain blue-black when in contact with iron. Tangential shrinkage during drying (to 5-percent moisture content) was 12 percent of green width. Drying schedules are tabulated. No special gluing difficulties were encountered. A large proportion of the 4 by 8-foot panels fabricated were grade 2 on the best face.

Altuhov, U. F. 1964. Trial of steaming veneer flitches in autoclaves. Derev. Prom. 13(5): 20-21.[5]

A brief description of the design and operation of an autoclave with a comparison of its advantages over pit steaming.

Corder, S. E., and G. H. Atherton. 1963. Effect of peeling temperatures on Douglas-fir veneer. Oregon State Univ. For. Res. Lab. Inform. Cir. 18. 31 pp.

Heated blocks yielded veneer that was tighter (that is, depth of lathe checks was less and tensile strength perpendicular to the grain was greater) than veneer from unheated blocks. Depth of lathe checks was reduced greatly by heavy pressure on the nosebar; but such pressure caused excessive compression that weakened the wood. Roughness of veneer and variation in thickness were not reduced by heating the blocks before peeling. There appeared to be a slight increase in strength of veneer parallel to the grain when blocks were heated before peeling. It was concluded that optimum temperature for peeling Douglas-fir is 140°F. Shelling or separation of wood at the springwood-summerwood boundaries was noted in veneer steamed at 200°F. for 103 hours.

Feihl, O., and V. Godin. 1963. Accurately adjusted lathe key to thin veneer cutting. Can. Wood Prod. Ind. 63(9): 26-29.[5]

Describes successful trials in rotary cutting of thin (1/28 to 1/85-inch) yellow birch veneers from straight and curly-grained bolts. Accurate lathe adjustments were required to avoid major defects. Heat distortion was minimized by cutting at 120°F. Optimum settings are reported.

Feihl, A. O. 1964. Rotary cutting of curly yellow birch. Can. Dept. For. Pub. 1086. 18 pp.

Logs should be heated in water 175°F. until the core reaches 150°. Heating time ranges from 6 hours for a 6-inch log to 98 hours for a 36-inch log, assuming initial log temperature of 70°F. For 1/28-inch veneer, optimum knife angle is 90° on a 21-inch bolt and decreases steadily to 88° and 30 minutes at 9-inch diameter. Optimum practical vertical nosebar opening is 0.01 inch in conjunction with a horizontal opening of 0.03. A 20° knife bevel (sharpness angle) is practical. Angles for thicknesses other than 1/28-inch are tabulated. Optimum nosebar angle was from 10° to 14°. When cutting veneer thicker than 1/28-inch (1/24- and 1/20-inch) danger of raising the fibers increased rapidly. Veneer laid up with the loose side out could be sanded much smoother than if the tight side was out. With close control of machine settings, a high proportion of grade A and grade 1 plywood can be produced from curly birch logs.

Feihl, O., and V. Godin. 1964. Some guidelines for cutting veneer from eastern hemlock. Can. For. Ind. 84(12): 36-39.[5]

In laboratory trials hemlock was successfully cut at 70°F. on a rotary lathe with a motorized roller bar and a knife with a main bevel angle of 21° 30 minutes, 30° microbevel, and 0.020 inch wide at the tip. Optimum settings are given for five veneer thicknesses. Grade was low, and recovery of green veneer was only 57 percent, although all met U.S. Fed. Spec. PPPV-205a.

Felescuk, V. N. 1964. Effect of the sharpness angle of the nosebar and of its position relative to the knife, on the resistance of wood to peeling. Lesn. Z. Arhangel'sk 7(4): 91-96.[5]

Evaluates, for birch, the effect of nosebar sharpness angles of 44°, 51°, 58°, 65°, and 70° in combination with angles between nosebar and knife of 72°, 76°, 80°, and 84°.

Felescuk, V. N. 1964. Effect of the position of

the knife relative to the bolt on the resistance of wood to peeling. Lesn. Z. Arhangel'sk 7(5): 129-136.

On birch, the knife clearance angle should be 1 to 1-1/2 degrees. The knife edge should be level with, or 1 millimeter above, the spindle centerline.

Fleischer, H. O., and J. F. Lutz. 1963. Technical considerations for manufacturing southern pine plywood. For. Prod. Jour. 13(1): 39-42.

Concludes that conditions are favorable for establishment of a southern pine plywood industry. Suggests peeling temperatures between 150° to 180°F. and a moderate drying temperature such as 300°F. A plant to produce 30 to 36 million square feet of 3/8-inch plywood per year would cost, at minimum, $1.5 million. One board foot log scale will yield 2.4 square feet of 3/8-inch plywood. Overlays should be applicable to southern pine plywood.

Grantham, J. B., and G. H. Atherton. 1959. Heating Douglas-fir veneer blocks—does it pay? Oregon For. Prod. Res. Center Bull. 9.

Preheating veneer blocks reduces splitting and thus increases recovery of A-grade veneer. The net gain in value is estimated at $4.35 per 1,000 log scale for No. 2 peelers and $12.83 for special mill logs. Heating vaults are estimated to cost $73,000 for a mill peeling 90,000 feet board measure daily. Steam is estimated at $0.178 per 1,000 board feet, while all heating costs might total $0.823 per 1,000.

Hoadley, B. R. 1963. Influence of certain variables on veneer cutting behavior. For. Prod. Jour 13(12): 538-548.

A laboratory-scale apparatus was used to study the effects on equilibrium cutting properties (final equilibrium condition attained after several cuts) of systematically introduced wood and tool variables. Energy consumption, block strain recovery, and veneer tensile strength increase with increasing nosebar pressure, while check depth, surface roughness, and veneer thickness decrease. Increasing the knife angle (the angle between the back of the knife and a line perpendicular to the cutting plane) generally reduces energy consumption and strain recovery. Cutting at higher temperature reduces energy and improves veneer quality, while effect on strain recovery is related to the nosebar pressure. At high temperatures, optimum nosebar pressure (with respect to veneer tensile strength retention) is decreased. Cutting fully saturated wood involves greater energy and strain recovery and results in thinner veneer of lower tensile strength. Specific gravity affects energy consumption but is not correlated with strain recovery of thickness. Growth ring orientation affects cutting behavior.

Knospe, Lothar. 1964. The influence of the cutting process in slicing and peeling on the quality of veneers. Holztechnologie (Dresden) 5(1): 8-14.

A review of factors affecting veneer cutting, including cutting speed, knife angles, nosebar, deformation of knife and nosebar, and deflection of the core. The author draws heavily on Fleischer's research. The bibliography lists 82 pieces of world literature on veneer cutting.

Koch, P. 1964. Beams from boltwood: A feasibility study. For. Prod. Jour. 14(11): 497-500.

Final paper of a series of four that explore the technical and economic aspects of converting small southern pine logs into thick-sliced veneer and then into long laminated beams of uniform high strength. Laminae are located in each beam according to their stiffness. Both technically and economically, the proposed system appears promising. Application depends on the anticipated development of a practical slicer that will produce a green veneer 0.6 inch thick.

Koch, P. 1965. Effect of seven variables on the properties of southern pine plywood: Parts I, II, III, and IV. For. Prod. Jour. 15(9, 11, 12): 355-361, 463-465, and 488-499.

Only the effects of one of the seven variables (i.e., peel) is here abstracted. Veneer peeled cold and loose had significantly higher wood failure, lower wet shear strength, lower dry rolling shear strength, lower compression strength parallel to the grain, and more severe face checks than veneer peeled hot and tight, Shear specimens tended to fail at or near loose-to-loose rather than loose-to-tight interfaces.

Krames, U. 1963. The setting of rotary veneer peelers on the basis of recent research results. Holzforsch. und Holzverwert (Vienna) 15(1): 11-18.

A summary of literature.

Krames, U. 1964. Some recent findings in veneer slicing. Holzforsch. und Holzverwert (Vienna 16(5): 90-96.

Reviews the work of Hoadley, Kivimaa, and Lutz.

Lutz, J. F., and R. H. McAlister. 1963. Processing variables affect chestnut oak veneer quality. Plywood Mag. 4(3): 26-30.

Rotary-cut and sliced veneer from slow-growing (12 rings per inch), 2-foot diameter, clear logs of chestnut oak (*Quercus prinus* L.) was converted into panels and flooring. Chestnut oak is in the white oak group but has pores not blocked by tyloses. Conditioning temperature prior to peeling had little effect on veneer roughness. An increase in peeling temperature increased the tensile strength of sliced veneer perpendicular to the grain except when the heat treatment was sustained,

for example, a 4-day heat treatment at 180°F. caused decreased strength. With increased peeling temperature, volumetric drying shrinkage of the veneer increased. Veneer cut from heated bolts was darkened by both increased temperature and increased time. End-splitting of bolts occurred above 180°F. A 200°F. water bath is recommended to bring the flitches to 190°; for bolts the water-bath should be only 150°F. to bring the core to 140°. For 1/8-inch veneer, either sliced or rotary cut, a horizontal fixed nosebar opening of approximately 0.115 inch in conjunction with a vertical opening of approximately 0.029 inch was optimum. The best veneer was produced by quarter-slicing, next best by rotary cutting, and poorest by flat-slicing. A conventional veneer dryer operating at 230° to 300°F. was satisfactory, but press drying at 300°F. was faster. No problems were encountered in gluing.

Lutz, J. 1964. How growth rate affects properties of softwood veneer. For. Prod. Jour. 14(3): 97-102.

Photographs illustrate the effects of growth rate on shelling and knife checking in southern pine and Douglas-fir veneer. The relation of growth rate to air drying, performance in glue bonds, and exterior exposure is discussed. Wood of both species reacts similarly during processing, and slow growth is desirable from the standpoint of reduced lathe checking, shelling, and warping.

Maul, Karlernst. 1964. Chucks for rotary veneer lathes. Holz als Roh- und Werkstoff 22(9): 352-355.

General discussion and comparison of designs.

Nikolaev, A. F. 1963. The magnitude and direction of deflection of small diameter bolts in peeling. Derev. Prom. 12(9): 15.[3]

The maximum deflection of veneer bolts 180 to 200 millimeters in diameter and 1,700 millimeters long was 12 millimeters. The horizontal component of deflection varied both in magnitude and direction. Nosebar compression had a considerable effect.

Tarsis, Ju. D., and Ju. I. Samohvalov. 1965. Peeling with a constant cutting speed. Derev. Prom. 14(4): 7.[3]

A mathematical analysis describing the advantages of continuous regulation of peeling speed.

Northcott, P. L., and D. C. Walser, 1965. Veneer-roughness scale. British Columbia Lumberman 49(7): 80-89.

The authors devised a dial gauge for measuring the amplitude and frequency of peaks and troughs on the veneer surface. From these measurements, they developed a visual roughness scale suitable for both research and quality control applications.

Chipping, Flaking, Hogging, and Grinding for Wood Flour

Anon. 1965. Small logs processed efficiently by Selectric "Beaver" system. Pulpwood Prod. 13(2): 12.

Analysis of advantages in "Beaver" peripheral-milling type of chipping headrig for random-length logs. Elimination of 1/4-inch kerf on each cant face increased chip recovery by 2,000 cubic feet of solid wood per 8-hour shift, assuming 6-inch cant faces and average sustained feed speed of 100 feet per minute (maximum lineal feed speed is 183 feet per minute). At a chip price of $6 per ton, the additional revenue from kerfless conversion as compared to conventional sawing, is $360 per 8-hour shift. Seven-inch logs 8 feet long have a Scribner log scale of 10 board feet. Average recovery from such logs was 16 board feet, that is, 60-percent overrun. Data based on operating experience.

Buchanan, J. G., and T. S. Duchnicki. 1963. Some experiments in low-speed chipping. Pulp and Pap. Mag. Can. 64(5): T235-T245.

Laboratory-scale investigation of the mechanics of pulpwood chipping was conducted. Chipping in the conventional mode and in the parallel and near-parallel cutting modes was studied with knife angles of 20° to 50° and a cutting speed of 50 centimeters per minute. Chipping work increased with knife angle and was generally greater for conventional than for near-parallel chipping. Departure from strict parallelism increased the work rapidly. Axial deformation in the grain direction greater than 1 percent could be observed in all conventional chips at their bruised ends and occasionally in the body of the chips. In near-parallel chipping no axial deformation greater than one percent could be observed, although deformation perpendicular to the grain was large. All conventional chips were damaged more than the parallel and near-parallel chips. Paper has 19 references.

Dobie, J., and C. F. McBride. 1964. Lumber and pulp chips from small logs. British Columbia Lumberman 48(9): 60, 62, 64.

A new machine, the Chip-N-Saw, operating on the peripheral milling principle, profiles debarked logs in 2-inch steps with a series of chipper heads. The cants are then converted to lumber by an in-line sawmill. Stated capacity is 80,000 board feet of lumber per 8-hour shift on logs 12 inches in diameter and less (averaging 9 inches). The average study log had a 9.7-inch top diameter, was 14.7 feet long, and yielded 64 board feet of 4/4 and 8/4 lumber (7.9 board feet of lumber per cubic foot of log). Overrun of lumber over B.C. Log Scale was 56 percent. Sawdust volume, 7 percent of log volume, was 1/3 to 1/2 of that from a conventional sawmill. Chip yield per 1,000 board feet of lumber recovered was equivalent to 40 cubic feet of solid wood or about 1,000 pounds ovendry. Relative lumber recovery was higher from short than from long logs.

Erickson, J. E. 1964. An investigation of power requirements for chipping hardwoods under various cutting conditions. Woodl. Sect. Index, Canad. Pulp and Pap. Assoc. No. 2301 (B-1) Appendix B: 4-5.

Square sugar maple cants 4 by 4 inches by 8 feet long were chipped on a 39-inch, 3-knife chipper at 225 rpm. Chipping power was observed by measuring torsional strain on the chipper shaft and relating this strain to torque. Vertical spout angles in the range from 0° to 60° had no significant effect on specific chipping energy. A 30° side spout angle decreased specific cutting energy slightly in comparison with a 0° angle. The average of all tests with knife angles (sharpness angle or rake?) of 30°, 40°, and 50° showed specific cutting energy to be respectively 8.25, 11.4, and 13.9 horsepower hours per cord. These values are for 1/2-inch chips and 85 cubic feet of solid wood per cord.

Hartler, N. 1963. Some model studies of wood chipping in a laboratory machine. Svensk Papperstidning 66(16): 587-599.[5]

Describes apparatus for studying various factors in chipping spruce rods 20 by 20 millimeters in cross section. 1) No significant difference in quality (determined by pulping) was found between chips produced at the beginning of the cutting action and those produced further along the cutting plane. 2) Impact force when the knife first hits the wood, chip damage, and, as a rule, chipping force increased and chip thickness slightly decreased, with increasing cutting speed. 3) Impact force increased gradually with increasing sharpness angle, whereas chipping force remained fairly constant at approximately 15 kiloponds per centimeter for angles of 25° to 40°, but rose to approximately 40 kiloponds per centimeter for an angle of 20° (possibly because of blunting of the 20° knife). Chip thickness was unaffected by variations in the angle. Chip damage generally increased with increasing angle. 4) Temperature in the range 5° to 50°C. had no effect on either chipping or impact force, but both increased noticeably with increasing dry matter in the range 60 to 90 percent. Chip damage and chip thickness decreased with increasing dry-matter content but were not affected by changes in temperature. 5) Photographs showed that cracks, formed along the grain direction when the knife penetrated the wood, start at the edge of the knife regardless of cutting speed when in the range 5 to 20 meters per second.

Hartler, N. 1963. Shear mainly perpendicular to the fiber axis — a new chipping principle. Svensk Papperstidning 66(17): 650-658.[5]

Discusses the three phases (cutting, shearing, and breaking) of the chipping process and the effect of loads applied parallel or perpendicular on wood shear strength. Compares strength properties of acid bisulphite pulp from chips compressed either parallel or perpendicular to the grain. Describes and illustrates a new chipper in which the main force is directed perpendicular to the longitudinal axis of the log. Chips obtained in the experimental run were of high quality.

Irvine, J. E., and E. W. Henderson. 1953. Wood chipper and chipper motor selection. Pulp and Pap. Mag. Can. 54(3): 247-252.

Choice of small chippers should be based on average and maximum wood diameters, capacity in cunits of roundwood desired, and desired chip length. Squirrel-cage induction, wound-rotor induction, and synchronous motors are discussed. Pull-out torques of 250 percent are essential, and windings of stator and rotor must be capable of withstanding the large starting loads occasioned by inertia of the chipper disks.

Jorgensen, R. N. 1964. The pros and cons of saw types used in pulp chip production. For. Prod. Jour. 14(4): 152-154.

Brief restatement of four of the several methods of producing sawdust having sufficient particle size to be pulped. Mentions 1) U.S. Forest Products Laboratory research on extreme bites per tooth and on 2) the Duo-Kerf saw, 3) step-sawing with the Griffsaw, 4) peripheral milling research at the Southern Forest Experiment Station with production machines typified by the Beaver and the Chip-N-Saw. Mentions the static saw for kerfless cutting by means of a stationary series of knives through which the log is moved.

Koch, P. 1964. Square cants from round bolts without slabs or sawdust. For. Prod. Jour. 14(8): 332-336.

Three unconventional headrigs were invented and tested. Each is capable of cutting, in a single 12-second operation, an accurately sized, heart-center S4S cant plus pulpable chips (or flakes for flakeboard). Neither sawdust nor slabs are produced. Specific cutting energy for 3/4-inch-long pulp chips cut from green slash pine by the END-MILLING configuration averaged 0.011 horsepower minute per cubic inch of wood removed, whereas with the PERIPHERAL-MILLING configuration the average was only 0.0023 horsepower minute. Flakes for flakeboard cut 1 inch long and 0.015 inch thick were made at an expenditure of 0.009 horsepower minute per cubic inch of wood removed with the SHAPING-LATHE configuration. Chip types, machine designs, and flow-plan sequences are illustrated. The headrigs are designed for logs of uniform short lengths and variable, but small, diameters.

Korcago, I. G. 1964. The shape, dimensions, and quality characteristics of machine chips. Lesn. Z. Arhangel'sk 7(2): 103-107.[5]

Analysis of the difference between planer shavings and specially made chips.

Kotesovec, Valdimir. 1964. Formation of long chips in longitudinal sawing of wood. Holz. 22(8).

Chip-forming blades of small diameter and large gullet area were mounted on shafts arranged one above the other so as to successively increase the depth of cut. Particleboard from the chips was as strong as that from conventional chips.

Licman, E. P. 1963. Investigation of the process of cutting wood into thick chips with a single cutter. Lesn. Z. Arhangel'sk 6(3): 122-133.[5]

A theoretical and experimental study with a special apparatus for moving the work against a fixed knife at 20.7 millimeters per second. For improving chip quality while reducing power consumption in drum-type chippers, clearance plus sharpness angle should be as small as possible; the angle between the velocity vector and the wood grain should be small (approximately 30°, maximum 50° to 55°); the clearance angle should be small or nil; moisture content should be 70 to 100 percent. Chip width has no effect on chip quality.

Licman, E. P. 1964. Investigations of the process of wood comminution by the DR-04 chipper. Gidrol. Lesohim. Prom. 17(2): 10-13.[5]

Under optimum conditions, power consumption by a drum-type chipper was 1.162 to 1.331 KW-hour per cubic meter with a yield of 78 percent of the standard chip fraction. The angle of incidence (not defined) should be as large as possible on drum-type chippers, the optimum being 65° to 75°. The complement of the cutting angle (rake?) should be as small as possible, that is, 30° to 40°. Wood moisture content should be as high as possible.

Miller, R. L., and C. W. Rothrock, Jr. 1963. A history of chip shredding. TAPPI 46(7): 174A-178A.

Experiments at the University of Florida in high-yield kraft pulping have shown some advantages from increasing the exposed surface of wood chips by splitting along the natural lines of cleavage without breakage across the grain and without crushing or otherwise mechanically damaging the fibers. The chief gains are: 1) high-yield pulps more easily produced, 2) chip screens eliminated, 3) knot breakers eliminated or operated lightly, 4) washing improved, 5) fiberizing power reduced, 6) pulp made cleaner, 7) cooking time reduced, and 8) digestion production increased.

Ostroumov, I. P. 1965. Trial in producing pulp chips when sawing with circular saws. Derev. Prom. 14(1): 9-10.[5]

Describes trials of suitability for sulphate pulping of chips (kerf material) produced by ripsawing Scots pine with circular saws of various designs. Feeds of 10 to 15 millimeters per tooth were satisfactory. Best tooth configuration was: 1) rake angle at least 35°, 2) clearance angle 10° to 15°, and 3) sharpness angle 35°. Moisture content of the logs should be greater than 45 percent.

Pahlitzsch, G., and J. Mehrdorf. 1962-1963. Manufacture of chips with horizontal flat disk chippers. I. Effect of chipping thickness and wood moisture content on chip production. II. Effect of cutting velocity, chip angle, and cut surface angle. III. Effect of knife-edge angle, inclination angle and cutting direction on chip production. IV. Chipping of poplar compared to pine. Holz als Roh- und Werkstoff 20(8): 314-322; 20(10): 408-418; 20(11): 443-453; 21(4): 144-149.

A series of four papers which examine in detail the many complicated factors affecting chip quality and machine performance.

Pahlitzsch, G. 1965. Production of wood chips with a cylinder type chipping machine. Holz als Roh- und Werkstoff 23(10): 403-412.

A versatile experimental machine was used for measuring cutting force on the tool and feed force on the work. Power consumption increased with chip thickness, while specific cutting energy decreased. Depth of cracks, roughness, curling, quantity of fines, thickness variation, and percentage of coarse chips were also affected. High moisture content increased the number of coarse chips and reduced fines. Thin chips from dry wood had greater roughness, curvature, and thickness variation. Lower cutting velocities reduced power consumption and improved chip surface uniformity, although output was reduced and the machine clogged at times. If chip collection space is inadequate, the chips will be crushed and power consumption will increase.

Pease, Lionel. Undated (1964?). A new program for cutting small logs at very high speeds. Unpublished paper by Mill Equipment, Inc., Seattle. 9 pp.

Describes capabilities of the "Beaver" four-head, peripheral-milling, chipping headrig for random-length logs. Manufacturing rights have since been acquired by Stetson-Ross, Seattle, Wash.

Scherfke, R., and L. Knospe. 1965. Manufacturing chips for the surface layer (of boards) on a cylinder-type chipper. Holztechnologie (Dresden) 6(3): 192-198.

If wood has a moisture content of 80 percent, a cylinder-type chipper is more economical than a disk chipper for producing quality chips for flakeboard. Sliver-like particles must be screened from the cut material.

Schmutzler, W. 1963. Knife disks and blocks for chippers. Holz als Roh- und Werkstoff 21(10): 410-415.[5]

A general discussion of design and quality requirements for knife disks and blocks so as to optimize chip quality and work efficiency.

Schmutzler, W. 1964. Feed systems on chippers. Holz als Roh- und Werkstoff 22(6): 237-241.

Diagrams various magazine feeds for peripheral and disk chippers (or flakers). Both random-length and cut-to-length wood considered.

Valscikov, N. M. 1964. Disk wood chippers. Izdatelstvo Lesnaja Promyslennlst, Moscow. 207 pp.[5]

An engineering manual covering the design and operation of disk chippers.

Wretne, Arne. 1965. Trends in chipping at the sawmill. Northern Logger 14(3): 13, 15.

Briefly describes the "H-P Canter," which reportedly is capable of slabbing (in one pass) two sides of random-length logs. Sixty-six knives are mounted in spirals on each of two cutterheads. Each cutterhead has the shape of a hollow and relatively flat truncated cone. Each knife cuts on two edges. Fibers are severed and wood is removed in a modified end-milling configuration to form pulp chips. No sawdust or slabs are generated. Logs up to 26 inches in diameter can be slabbed to 18 inches in one pass. If desired, the cutterheads can be brought together and the entire log chipped. The machine requires 150 horsepower, feeds at 160 linear feet per minute, and requires no heavy foundation. A nomogram relating log diameter, feed rate, and cords per hour is included. Feedworks for centering log not illustrated.

Defibrating

Anon. 1963. Symposium on refiner groundwood. Tech. Sec. Proceedings, Pulp and Pap. Mag. Can.

Panel discussion of operating variables and recent research.

Atack, D., and W. D. May. 1962. Mechanical pulping studies with a model steel wheel. Pulp and Pap. Mag. Can. 63(1): T10-T20.

At low speeds, friction was the sum of surface friction and a component arising from the viscoelastic deformation of the wood. Surface friction decreased as speed increased, approaching zero for some conditions of cylinder radius and specific load. Under certain conditions, energy was sufficiently localized to cause charring below the wood surface. It is concluded that a large fraction of the grinding energy in commercial units is dissipated in viscoelastic deformation of the wood.

Atack, D., and W. D. May. 1963. Mechanical reduction of chips by double-disk refining. Pulp and Pap. Mag. Can. 64(C): T75-T83, T118.

The plate pattern was ground from the surface of a refiner disk in a series of stages. Chips were fiberized and examined. Results indicated several distinct phases in refining. Match-stick fragments are produced in the breaker-bar section. Further breakdown occurs toward the center of the disk, and groups of fibers assume a cylindrical shape. Lastly, small fragments are refined into paper pulp.

Dorland, D., et al. 1962. Mechanical pulp from chips—laboratory refining of softwood and hardwood species. Pulp and Pap. Mag. Can. 63(2): T43-T52.

Disk-refined spruce produces pulp superior to stone groundwood at any freeness down to 50 milliliters. Pretreatments like steaming and chemical dips are effective on spruce and soft hardwoods. Dense hardwoods require more drastic treatment. Power requirements are high, but the disk-refining process is more flexible and can be accurately controlled.

Holzer, W. F., et al. 1962. The development and production of disk-refined groundwood pulp. TAPPI 45(3): 208-213.

Best results were obtained with plates having narrow radial bars and grooves and numerous intermediate dams. Optimum conditions include: 1) two-stage refining, 2) application of 30 to 50 percent of total power in first stage, 3) a 15-percent or higher consistency, and 4) best possible uniformity of feed.

Lamb, G. E. R. 1960. The efficiency of mechanical pulping processes. TAPPI 43(11): 939-944.

The mechanical energy to produce a unit area of surface is measured. The results are on the order of 10^5 ergs per square centimeter and indicate that the efficiency of mechanical pulping may be about 20 percent, whereas previous estimates were about 0.010 percent.

Neill, M. T., and L. R. Beath. 1963. Supergroundwood: Its manufacture from chips and use as a sole newsprint furnish. Pulp and Pap. Mag. Can. 64(7): T299-T312.

A discussion of groundwood production on a commercial scale. A hypothesis of the mechanism of refining is given along with the effects of single operating variables on handsheet properties.

Robinson, S. J. 1965. Production of groundwood from chips. TAPPI 48(4): 48A-51A.

A practical discussion of groundwood production on a commercial scale.

The second part of this article will be continued in the October issue of the Forest Products Journal.

Part 2

Wood Machining Review, 1963 Through 1965

By

Peter Koch and C. W. McMillin

Southern Forest Experiment Station
Alexandria, La.

THIS IS THE SECOND and last part of an examination of significant research in wood machining. The reviewers' principal sources were the major world journals in wood science and technology, *Forestry Abstracts*, and personal communication with researchers known to be active. The first installement appeared on page 76 of the September Yearbook issue of the *Forest Products Journal*.

Properties of the Cutting Edge and Cutter

Tool Materials

Antoine, R. 1963. The joint action of stellite facing and reduction in speed on tool life in sawing abrasive timbers. Bois et For. Trop. No. 90: 33-38.[1]

In Parinari, the length of sawing time without blunting was 8 times greater with stellite-faced teeth than with ordinary saw teeth. Saw speeds ranged from 500 to 2,500 meters per minute. A 40-fold increase in sawing time without sharpening could be expected with stellite and the slower speed.

Borovschi, B. 1964. The use of ceramic material for woodworking tools. Stud. Cerç. Inst. Cerc. For. (Bucharest) 24: 246-256.[1]

Describes the properties of a ceramic tool material and the results of machining tests.

[1]The citations and abstracts marked with a superscript 1 are taken by permission (with some revision) from Forestry Abstracts, Commonwealth Forestry Bureau, Oxford, England.

Byzov, V. 1964. Treating the cutting tool with MoS_2. Lesn. Prom. 12(27).[1]

On gangsaws, treatment was ineffective across the width of the tooth face but reduced the height wear 50 percent.

Fessel, Friedrick. 1964. Hard-alloy tools for the working of wood and wood-base materials. Holz als Roh- und Werkstoff 22(10): 386-392.

For machining solid timbers as well as laminates, tools tipped with hard alloys offer the advantages of increased life, reduced adjusting time, and reduction of later finishing operations.

Gorskova, A. N., I. E. Serman, and V. A. Sannikov. 1965. Hardening cutting instruments with MoS_2. Derev. Prom. 14(3): 23-24.[1]

Tools are first sharpened, degreased, and washed, and then boiled 15 to 20 minutes at 95° to 100°C. in a mixture of 1 part MoS_2 powder (by weight) and 8 to 10 parts water. Approximately 300 cutters can be treated with 300 grams of MoS_2. Treatment increased cutter service life 20 to 50 percent.

Haidt, H. 1964. Necessary considerations in the use of hard-alloy tools in industries working wood and plastic. Holz als Roh- und Werkstoff 22(9): 345-351.[1]

A discussion of the properties of solid wood, particleboards, fiberboards, and plastic as they affect the use of hard-alloy-tipped circular saws and molding cutters. Formulae and data are tabulated to aid in selecting the optimum tool and cutting conditions.

Knudsen, M. 1963. A study of hard metal for cutting. Traeindustrien 13(5): 65-69.[1]

On birch plywood, saws tipped with tungsten carbide cut 25 to 50 times as long as saws of high-speed steel and 10 times as long as stellite-tipped saws. Tool wear is illustrated, and recommendations are given on cutting angles and sharpening methods.

Melehin, L. F. 1963. An effective method of increasing the durability of wood-cutting saws. Derev. Prom. 12(12): 5-8.[1]

Trials with laminated birch compared a large number of saw-tooth materials (steels and hard alloys) applied either by deposition or in the form of welded tips. With tooth wear of conventional steel rated at 1, several high-speed steels were rated at 2.3 to 3.1, proprietary alloy at 7.2 to 7.6, and stellite at 11.

Serov, N. A., and V. Ja. Rublev. 1965. Trial in treating a tool with MoS_2. Derev. Prom. 14(7): 27.[1]

Zaharenko, I. P., I. H. Cepoveckij, and D. A. Sirota. 1963. Knives with hard-alloy tips glued on. Derev. Prom. 12(6): 23-24.[1]

Describes a technique for gluing tips to planing and molding cutters and the successful results of trial runs.

Dulling Phenomena

Borovikov, E. M. 1963. Measuring the wear of frame-saw teeth with a large projector. Derev. Prom. 12(8): 16-17.[1]

Chardin, Andre. 1965. Evolution and recent developments in the study of saw tooth wear. IUFRO, Sect. 41, October Meeting, Melbourne. 16 pp.

Englesson, Torsten. 1964. A method for comparing the tool-wearing properties of wood-based materials. Svensk Papperstidning 67(24): 985-989.

The material to be tested (30 millimeters thick and 900 millimeters long) is mounted in a clamping device sloped so that free surfaces of gluelines will not wear at any particular spot on the knife. The material is then fed past a rotating cutterhead having one knife cutting and one balancing. A fixed depth of cut is maintained. Change in power demand, as measured by a wattmeter, is the measure of dulling rate. To further monitor tool wear, the cutting edge can be photographed at 10X without removing the knife from the head. Net cutterhead power is plotted against calculated length of tool path in the material.

Halvorson, H. N., and W. M. P. Stuart. 1963. Improvement of sawmill cutting tool sharp life by surface hardening. For. Prod. Jour. 13(3): 108-111.

Whereas unplated gangsaw teeth became dull and lost 5.5 percent of swaged tooth-width in 4 hours of cutting western red cedar, electrolytically chrome-plated swaged teeth maintained satisfactory edges for 8 hours and lost only 1.8 percent of tooth width. The more economical process of spark impregnation (whereby the transfer of tungsten carbide takes place through an arc passing from the anode composed of the impregnating carbide to the metal tooth which is the cathode) increased service life on western hemlock from 4 hours for untreated saws to over 8 hours for treated saws. Spark impregnation with tungsten carbide did not slow the rate of wear in tooth width, that is, tooth sharpness was maintained as the tooth wore.

Hillis, W. E., and W. M. McKenzie. 1964. Chemical attack as a factor in the wear of woodworking cutters. For. Prod. Jour. 14(7): 310-312.

Wood cutting tools wear by contact with dirt and through friction and chemical attack. Blue-staining of steel tools is evidence of chemical corrosion. Microscopic examination of such stains revealed a raised layer of material which, when

removed with dilute caustic soda, revealed the grain structure of the steel etched on the polished surface. Because acetic acid and tannins occur in wood, these compounds were investigated. In 30 minutes, acetic acid in a 0.6-percent aqueous solution at a pH value of 3 caused etching 0.06 micron deep in polished carbon steel. At pH 4 the action was less severe. Phenolic compounds common in wood extractives (for example, tannins) were applied in solutions ranging up to pH 6 and were found to etch iron more or less severely than did acetic acid, depending on the compound. Those containing three vicinal phenolic groups (gallic acid, pyrogallol, and gallocatechin) attacked the cutter more quickly than compounds containing two such groups (catechin), but both were more corrosive than acetic acid. The protective value of an applied electro-potential was explored by insulating the cutter and pressing an electrode to the workpiece immediately in front of the cutter. A negative potential ranging from zero to 100 volts was applied to the cutter, and etching was much reduced, even when no voltage was applied.

McKenzie, W. M. 1962. The effects of edge condition in wood cutting. CSIRO Div. For. Prod. (S. Melbourne) Rept. 1, Experiment U. 11-11/1. 12 pp.

Blunting proceeds in three stages: 1) primary-initial equilibrium reached at the first contact of the ideally sharp edge with wood is caused by yielding of both cutter and wood; 2) secondary—the edge is abraded with increasing frictional forces; and 3) tertiary—the front and back faces of the cutter are abraded in the vicinity of the edge. An understanding of the blunting phenomenon requires consideration of chip formation, cutting force components, sharpening conditions, stresses at the cutter-wood interface, coefficient of friction, and mechanical properties of wood.

Nosovskii, T. A. 1963. The effect of bluntness in wood-cutting tools on cutting force, taking into account direction of grain and wood species. Lesn. Z. Arhangel'sk 6(3): 102-106. (Also CSIRO Australian 7176. 4 pp.)

1) The severance or incision force (as contrasted to chip formation, breakage, friction, and acceleration forces) depends solely on the radius of the cutting edge; hence the thinner the chip the stronger the effect of tool sharpness on total cutting force.

2) Average cutting force is equal to an initial cutting force plus an experimental constant times chip thickness plus a second experimental constant times chip thickness squared:
$(P = P_o + k_1 h - k_2 h^2)$.

3) With decreasing rake angle, sharpness of the cutting edge has a lesser effect on cutting forces.

4) Sharp knives are more effective in decreasing cutting forces on hard and inelastic woods (beech and hornbeam) than on soft, more elastic woods (spruce).

5) Sharp knives reduce cutting forces more effectively when cutting parallel to the grain than when cutting in the veneer direction.

Pahlitzsch, G., and K. Dziobek. 1961. On blunting of sanding belts in woodworking. Holz als Roh- und Werkstoff 19(4): 136-149. (Also translated by Joint Publications Research Service, Dept. of Commerce, Wash., D. C. FPL-649. Dec. 1965.)

Blunting was investigated with stereoscopic pictures of the coating and by examining individual grains with a profile projector. Wood surface roughness was measured with an electronic surface tester. Belts became blunt because abrasive grains were broken off or cut, and because fine wood material accumulated between grains. Other results were: 1) Roughness of wood surface increased (?) as belt dulled. 2) Under constant belt pressure, wood removed per unit of time decreased as belt dulled. 3) To remove a constant volume of wood per unit of time, contact pressure had to be continually increased as the belt dulled. 4) Cleaning a clogged belt did not guarantee substantial improvement.

Pahlitzsch, G., and Hans Jostmeier. 1964. Observations on blunting behavior with the milling of particleboard. Holz als Roh- und Werkstoff 22(4): 139-146.

Pine particleboard blunted knives of hard alloys and high-speed steel sooner than poplar particleboard though at an equal state of knife bluntness, poplar required more cutting power than pine. Knives blunted by poplar showed fairly regular wear along the length of the cutting edge, whereas pine caused irregular wear.

Pahlitzsch, G., and Hans Jostmeier. 1964. Further observations on blunting behavior and effect of cutting-rate in the milling of particle board. Holz als Roh- und Werkstoff 22(11): 424-429.

Tool wear depends primarily on density of the various layers of particleboard, but also on silicates and other impurities in the board. Formulae are given for calculating the most economic cutting rate.

Pahlitzsch, G., and Hans Jostmeier. 1965. Observations on blunting behavior in the milling of overlaid sandwich boards. Holz als Roh- und Werkstoff 23(4): 121-125.

Cutting velocities of 36 to 38 meters per second minimized cutting forces. Cutting forces were inversely related to rake angle. Cutter life was equal to a constant divided by cutting velocity raised to the 2.55 power. Rake angles 5° to 6° maximized cutter life. The stronger hard-alloy cutters improved tool life, although performance depended on the manufacturer of the alloy.

Pahlitzsch, G., and K. Dziobek. 1965. Investigations of the wear characteristics of a cutting tool. IUFRO, Sec. 41, October Meeting, Melbourne. 14 pp.

Prokes, S. 1964. Effect of the geometry of milling tools on their durability. Drev. Vyskum (3): 157-168.[1]

Prokes, S. 1965. Effect of cutting conditions on blunting of the cutting tool. II. Drev. Vyskum (1): 47-57.[1]

Fitting and Sharpening

Anon. 1963. Technical memos on sawing. Technical Center for Wood (Paris) Memos 1.5, 1.6, 1.7. 7, 6, and 4 pp. respectively.

Principles and application in swaging and shaping band saws.

Anon. 1964. Cracking of circular headsaw along the collar line. Philippines For. Prod. Res. Inst. Tech. Note 52. 3 pp.[1]

Describes saw-blade cracking attributable to transverse blade deflections. Tabulates causes, detection, and remedies of deflections.

Anon. 1964. Manual on upkeep and sharpening of band saws and chain saws. Notebooks from The Technical Center for Wood (Paris) Series II, Bull. 63. 59 pp.

Anon. 1965. Technical memos on sawing. Technical Center for Wood (Paris) Memos 1.8, 1.9, 1.10, and 1.11. 2, 6, 3, and 3 pp. respectively.

Band saw tensioning equipment and anvils (1.8), application of hard alloy (stellite) to saw teeth (1.9), truncation of alternate teeth (1.10), and tooth profiles (1.11).

Abeels, P. 1965. Effect of tensioning treatment on cutting force and blade behavior during sawing. IUFRO, Sec. 41, October Meeting, Melbourne. 7 pp.[1]

Barovikov, E. M. 1963. The effect of swaging and shaping on microhardness, micro-structure and distribution of deformations in frame-saw teeth. Lesn. Z. Arhangel'sk 6(1): 119-126.[1]

Swaging increased microhardness 50 to 60 percent over initial hardness. Deformations were greatest in the tooth tips at the point of contact between the tooth face and the swaging roller, and on the lateral shaped surfaces.

Barz, Eginhard. 1963. Comparative investigations on tensioning circular saw blades with machines and with hammers. Holz als Roh- und Werkstoff 21(4): 134-135.[1]

Barz, Eginhard. 1965. On stresses in band and disk-shaped tools. Part I—Non destructive determination of stresses in disc and band-shaped sawing tools. Holz als Roh- und Werkstoff 23(10): 412-419.

Correct saw tensioning is difficult because it is not easy to measure the stress at any point in the saw-plate. Hardened steel sheets change their ferromagnetic properties through cold forming, which thus affects inductive measuring methods. Because these methods are also affected by surface properties, interpretation of results is difficult. A radiographic method permits determination of size and location of surface tensions, from which the stress distribution can be calculated and plotted.

Barz, Eginhard. 1966. Residual stresses in band- and disk-shaped tools. Part II—Circular saw blades with working qualities independent from residual stresses. Holz als Roh- und Werkstoff 23 (12): 484-491.

Describes research to decrease saw fluttering by reducing temperature differences in the blade body or by alleviating the stresses caused by temperature differentials. Blades with elastic center zones —that is, perforated center zones—proved superior to those of the normal type when overstressed by temperature differentials.

Fonkin, V. F. 1963. On the nature of the deformation of frame-saw blades where they are rolled. Derev. Prom. 12(8): 27-28.[1]

Data on the micro-hardness of saw teeth after swaging do not support previous reports that rolling affects only the surface layers.

Fonkin, V. F., and M. M. Balabanov. 1964. The effect of cold swaging on hardness of the tips of saw teeth. Derev. Prom. 13(9): 13.[1]

On steel saw teeth having initial hardness of Vickers 448 cold swaging up to 300 percent increased the hardness by only 40, an amount insufficient to affect saw life.

Hensler, J. H., and D. S. Jones. 1965. Some research on the welding of bandsaws. Australian Timber Jour. 31(1): 53, 55, 57-59.

Band-saw welds prepared by experienced filers were examined to determine the likely causes of failure. Principal faults were: 1) fissures resulting from penetration of the solid bead into the parent metal during forging; 2) unsatisfactory post-welding heat-treatment; and 3) decarburization of the melt.

Jones, D. S. 1965. Gullet cracking in saws. Australian Timber Jour. 31(7): 22-25.

Several practices help to avoid gullet cracking: maintain light grinding pressures, minimize hammering and rolling (particularly near the tooth line), keep mounting tension in band saws and gang saws at a minimum and minimize rolled tension and

back crown to reduce longitudinal stress, correlate band saw thickness to wheel diameter, run circular saws at the lowest possible speed to reduce centrifugal stress and vibration, use swage-set teeth in preference to spring-set teeth on spring-set saws, minimize lateral tooth load by employing a square tooth front and minimum set, employ sturdy tooth profiles with generous gullet curvature, avoid nicks or sharp corners in gullets, keep saws sharp, maintain feedworks and saw guides in accurate alignment, and keep band saw wheels clean.

Metiann, I., and V. Sachelarescu. 1965. The anode-mechanical sharpening of cutting tools plated with metallic carbides as applied in the wood industry. Industria Lemnului 16(1): 8-14.[1]

Grinding costs are reduced approximately 13 percent with anode-mechanical tool grinding as compared to conventional abrasive grinding.

Stabiev, J. M. 1965. Machine for rolling circular saws. Derev. Prom. 14(2).[1]

Stability

Jones, D. S. 1965. An experimental analysis of saw tooth stress and deflection. IUFRO, Sec. 41, October Meeting, Melbourne. 21 pp.

In previous research by Jones, tooth instability limited the reduction of kerf in spring-set saws. Here Jones reports studies (by brittle-lacquer and photo-elastic techniques) in which he concluded that the best compromise is a profile very similar to the North American standard saw tooth: 30° rake and generously rounded gullet, but a clearance angle of 24° rather than 14°. In such a tooth, stresses are at a practical minimum under lateral and axial load, but mechanical sharpening is possible.

Kotesovec, V., and H. R. Loos. 1964. Vibration in carbide-tipped circular-saw blades. Holztechnologie (Dresden) 5(1): 26-32.[1]

Presents oscillograms and a table of critical, possible, and optimum speeds for 31 blades 200 to 500 millimeters in diameter, run at 200 to 13,500 rpm (rim speeds 3 to 300 meters per second). Diameter and thickness determine optimum speeds. Optima were generally higher than commercial practice, varying from 10,000 to 12,000 rpm for diameters of 100 to 150 millimeters, to 3,400 to 4,700 or 2,500 to 3,500 rpm (according to thickness) for a diameter of 500 millimeters. Blades of 350 millimeters diameter or more tended to have more than one critical (resonance) zone. Oscillation increased with cutting load, and with number or size of slits.

Mote, C. D., Jr. 1963. Effect of in-plane stresses on the vibrational characteristics of clamped-free discs. Univ. Calif. Dept. Eng. Doctoral Dissertation. 108 pp.

Mote, C. D. 1964. Circular saw stability—a theoretical approach. For. Prod. Jour. 14(6): 244-250.

To determine optimum tensioning conditions, such blade parameters as rotational speed, thickness, and temperature distribution were analyzed by fundamental structural stability theory. An optimum condition is proposed and illustrated by example.

Mote, C. D., Jr. 1965. Some dynamic characteristics of band saws. For. Prod. Jour. 15(1): 37-41.

Flexural natural frequencies always decrease with increasing band velocity, the rate of decrease being dependent on the pulley mounting system. Simple, accurate, and bounding fundamental frequency approximations are presented. The pulley mounting system determines whether the tension is constant (fixed pulley support) or increases parabolically (dead weight and lever mechanism) with saw velocity. From the standpoint of dynamic stability theory, the dead weight and lever mechanism now commonly used by the wood industry is best for high-speed saws.

Mote, C. D., Jr. 1965. Free vibration of initially stressed circular disks. Jour. Eng. for Ind. 87(2): 258-264.

The approximate free vibration characteristics of centrally clamped disks of variable thickness are analyzed by the Rayleigh-Ritz technique. Natural frequencies of transverse vibration are computed, taking into consideration rotational and thermal in-plane stresses as well as purposely induced initial stresses. Initial stresses can significantly raise the minimum natural frequency throughout a prescribed rotational and thermal environment. The fundamental mode of disk vibration is one of zero nodal circles and either zero, one, or two nodal diameters, depending upon the disk geometry and the rotational-thermal environment.

Thunell, B., and L. Kilström. 1962. The influence of sawtooth dimensions on lateral stability. Holztechnologie (Dresden) 3(2): 145-149. (Also CSIRO Australian Translation 6252. 7 pp.)[1]

Describes deflection of tooth tip under influence of lateral forces. Ninety-six types of triangular teeth without rounding at the base were tested, representing combinations of two thicknesses (1 and 2 millimeters), four tooth height ($h = 12$ to 24 millimeters), four angles ϕ (45° to 90°, ϕ being the angle between the tooth-base b and a line from its midpoint through the tip of the tooth), and three b/h ratios (0.375, 0.75, and 1.5). With other factors constant, deflection increased non-linearly with increasing h and with increasing b/h and ϕ. For a thickness of 2 millimeters and a load of 8 kiloponds, deflection varied from 0.01 millimeter for $\phi = 90°$, $h = 12$ millimeters, and $b/b = 1.5$, to 1.44 millimeter for $\phi = 45°$, $b = 24$ millimeters, and $b/b = 0.375$.

Thunell, B. 1963. Effect of gullet radius and shape of back on the lateral stability of a saw tooth. Holz als Roh- und Werkstoff 21(4): 133-135.[1]

Normal and curved-back frame saw teeth were 30 percent more rigid than straight-back teeth. A large gullet radius is important for lateral rigidity in these designs although of little value for symmetrical triangular teeth.

Thunell, B., and B. Noren. 1964. Stability investigations on frame-saw blades. Parts 1, 2, 3, 4, and 5. Pap. ja Puu 46(8) (10) (11) (12): 453-460, 565-573, 576-580, 665-678, 717-720.[1]

Background information 1), theoretical methods of studying stability 2), influence of thickness and blade tension on saw deflection and stress 3), graphs and tables with details of results 4), and validity and application of previous research 5).

Temperature

Atack, D., and I. T. Pye. 1964. The measurement of grinding zone temperature. Pulp and Pap. Mag. Can. 65(9): T363-T376.

Reviews previous attempts to measure grinding zone temperature and discusses measurement techniques. In the miniature grinder used here, a maximum of 104°C. was observed in the heated layer of wood at the grinding zone. The thickness of the heated layer was approximately 0.004 to 0.010 inch. The temperature at the stone surface did not exceed 100°C. Wood temperature determinations were also made on a commercial three-pocket Great Northern grinder. Temperatures were significantly higher than observed in the miniature grinder. It is concluded that although thermal softening of lignin and hemicelluloses may be a prerequisite, it is not the predominant factor in acceptable groundwood production.

Hawkins, B. T., and W. M. McKenzie. 1965. Temperature rise and moisture movement in wood cutting. For. Prod. Jour. 15(3): 101.

Heat generated by friction in cutting, dried out wood in the cutting zone and caused migration of moisture away from this zone. The cutting properties of wood were altered because 1) wood loses strength with rise in temperature, 2) dry wood is stronger than wet wood, and 3) dry wood has a lower coefficient of friction than wet wood. Dry wood has less heat conductivity than wet wood. Migration of moisture away from the cutting zone was observed in bandsawing ash eucalypt at 12.4 percent moisture content with feed parallel to the grain. When the saw was about 3 millimeters from the end-grain surface before emerging, a band of liquid water about the width of the kerf was observed on the surface because some of the vapor had diffused along the vessels ahead of the saw and condensed on reaching a cooler zone.

Research Instrumentation and Techniques

Ardenne, M. von, et al. 1963. Monitoring the attainment of given temperatures in steamed wood with a radio transmitter probe. Holztechnologie (Dresden) 4(3): 249-251.[1]

An instrument, consisting of a thermocouple and radio transmitter, is inserted into a hole in the core portion of a veneer bolt, and a signal is emitted when the minimum effective temperature (60°C.) is reached.

Borovikov, E. M. 1963. A test rig for investigating the process of frame-sawing. Lesn. Z. Arhangel'sk 6(3): 107-113.[1]

An apparatus for studying the effect of cutting and feed forces on tooth dulling.

Clark, L. N. 1963. A new dynamometer for measuring cutting forces in three dimensions. CSIRO, Div. For. Prod. (S. Melbourne) Tech. Pap. 30. 16 pp.[1]

Reviews existing techniques and describes a new three-dimensional "platform" type of dynamometer having 3 load cells, instead of the customary 4. The normal component of the load carried by each cell is registered by one set of 4 resistance-strain gages mounted on each cell. Associated electronic equipment includes a small computer that operates on these load signals and produces new signals that are a measure of the three forces under study.